CLAIMS

WHAT IS CLAIMED IS:

1. An optoelectronic waveguiding device, comprising:

at least two optoelectronic device elements, each having an optical waveguide; and

an optical waveguide made of a bulk crystal, wherein each of said optical waveguides in said at least two optoelectronic device elements are connected to each other with said optical waveguide made of a bulk crystal.

2. An optoelectronic waveguiding device according to Claim 1, wherein at least two of the optoelectronic device elements are built into a single semiconductor substrate.

3. An optoelectronic waveguiding device according to Claim 2, wherein at least a first of said at least two optoelectronic device elements is a semiconductor laser part and at least a second of said at least two optoelectronic device elements is an optical modulator part.

4. An optoelectronic waveguiding device according to Claim 3, further comprising:

a plurality of pairs, each pair comprising one of said semiconductor laser parts and one of said optical modulator parts, each of said plurality of pairs formed on a single substrate.

5. An optoelectronic waveguiding device according to Claim 1, wherein the optical waveguides of said at least two optoelectronic device elements each include a multiple quantum well (MQW) structure existing in a direction of a light propagation axis thereof.

6. An optoelectronic waveguiding device according to Claim 5, wherein said at least two optoelectronic device elements are further comprised of:

cladding layers each placed above or beneath the optical waveguides of said at least two optoelectronic device elements, wherein said cladding layers are comprised of a material having a refractive index lower than that of the optical waveguides of said at least two optoelectronic device elements.

7. An optoelectronic waveguiding device according to Claim 6, wherein said optical waveguide made of a bulk crystal comprises a semiconductor bulk crystal having a refractive index higher than that of said cladding layers.

8. An optoelectronic waveguiding device according to Claim 5, wherein said at least two optoelectronic device elements including an MQW structure have mutually different functions.

9. An optoelectronic waveguiding device according to Claim 8, wherein said two optoelectronic waveguiding device elements having mutually different functions are a semiconductor laser part and an optical modulator part.

10. An optoelectronic waveguiding device according to Claim 5, wherein

said at least two optoelectronic device elements each having an MQW structure include a semiconductor laser part, an optical modulator part, and a semiconductor optical amplifier part;

wherein at least either the layer structures or constituent materials of the MQW structures are mutually different, and

further wherein said optical waveguide made of a bulk crystal exists at connection points between said optical modulator part and said semiconductor laser part and between said optical modulator part and said semiconductor optical amplifier part.

11. An optoelectronic waveguiding device according to Claim 9, wherein the MQW layer of the laser part has a different thickness than the MQW layer of the modulator part, further wherein said bulk crystal optical waveguide is tapered to interconnect the different thicknesses.

12. An optoelectronic waveguiding device according to Claim 5, wherein said at least two optoelectronic device elements including an MQW structure include a plurality of laser parts and a modulator part, said device further comprising:

an optical multiplexer including a, MQW structure; wherein said optical waveguide made of a bulk crystal is adapted to connect said plurality of laser parts

to said modulator part through said multiplexer, further wherein light emitted from one of the semiconductor laser parts is multiplexed by said optical multiplexer and made to enter said optical modulator,

13. An optoelectronic waveguiding device according to Claim 1, wherein

said at least two optical waveguides of the optoelectronic device elements are a MQW structure made of an InGaAlAs system material and a MQW structure made of an InGaAsP system material, and

said bulk crystal optical waveguide is made of a bulk crystal that is selected from a group consisting of InGaAsP system, InGaAlAs system, and InAlAs system materials.

14. An optoelectronic waveguiding device according to Claim 3, wherein

a layered structure that constitutes said optical modulator part comprises a MQW structure made of an InGaAlAs system material,

a layered structure that constitutes said semiconductor laser part comprises a MQW structure made of an InGaAsP system material, and

said bulk crystal optical waveguide is made of a bulk crystal that is selected from a group consisting of InGaAsP system, InGaAlAs system, and InAlAs system materials.

15. An optoelectronic waveguiding device according to Claim 3,

wherein both said optical modulator part and said semiconductor laser part have an MQW structure made of an InGaAsP system material;

wherein one of a thickness of the quantum well, a thickness of the barrier layer, and the number of cycles of the quantum wells which constitute the MQW structure of said optical modulator part is different from a counterpart of the MQW structure of the semiconductor laser part; and

further wherein the optical waveguide made of a bulk crystal that is selected from a group consisting of InGaAsP system, InGaAlAs system, and InAlAs system materials exists at a connection part between said optical modulator part and said semiconductor laser part.

16. An optoelectronic waveguiding device according to Claim 3,

wherein both said optical modulator part and said semiconductor laser part have an MQW structure made of an InGaAlAs system material;

wherein one of a thickness of the quantum well, a thickness of the barrier layer, and the number of cycles of the quantum wells which constitute the MQW structure of said optical modulator part is different from a counterpart of the MQW structure of the semiconductor laser part; and

further wherein the optical waveguide made of a bulk crystal that is selected from a group consisting of InGaAsP system, InGaAlAs system, and InAlAs system

materials exists at a connection part between said optical modulator part and said semiconductor laser part.

17. An optical module, comprising:

an optical fiber; and

a semiconductor optoelectronic waveguiding device comprising a plurality of device element structures each having at least a semiconductor laser part and an optical modulator part arranged side by side in a direction parallel to a light propagation axis in said semiconductor optoelectronic waveguiding device,

wherein said device element structures arranged side by side are capable of emitting light having the same wavelength or mutually different wavelengths, both said optical modulator part and said semiconductor laser part of each device element structure having MQW structures,

wherein layer structures or constituent materials of these MQW structures of each device element structure are mutually different, and

further wherein an optical waveguide made of a bulk crystal exists at a connection part of said optical modulator part and said semiconductor laser part of each device element structure.

18. An optical module according to claim 17, wherein said plurality of device element structures includes a plurality of semiconductor laser parts and an optical modulator part, said device further comprising:

an optical multiplexer including an optical waveguide capable of multiplexing light emitted from one of the semiconductor laser parts arranged side by side and subsequently transmitting the light to said optical modulator part;

wherein said semiconductor optoelectronic waveguiding device is capable of emitting single longitudinal mode light,

wherein said semiconductor laser parts and said optical modulator parts being formed on the same semiconductor substrate, and

further wherein the optical waveguide made of a bulk crystal exists at least in a portion of the optical waveguide in the optical multiplexer.

19. A method for manufacturing an optoelectronic waveguiding device, comprising the steps of:

forming a first optoelectronic device element on a semiconductor substrate;

applying a first resist layer to said first optoelectronic device element;

etching said first optoelectronic device element;

forming a second optoelectronic device element in said etched area on said semiconductor substrate;

applying a second resist layer;

etching said second resist layer to remove a crystal defect formed between said first and second optoelectronic elements; and

forming a waveguide from a bulk crystal in said etched crystal defect area, wherein said waveguide from a bulk crystal optically connects said first and second optoelectronic elements.

20. The method of Claim 19, wherein said first and second optoelectronic elements include MQW structures.